

NAG's Numerical Services help PSI to improve pump station efficiency for pipelines

PSI

PSI AG develops and integrates complete solutions for energy management (gas, oil, electricity, heat, energy trading), production management (mining, metals, automotive, mechanical engineering, logistics) and infrastructure management for transport and safety. PSI was founded in 1969 and employs 1,700 persons worldwide.

Background

A team from PSI, who are focused on oil and gas pipeline efficiencies, leak detection and pipeline monitoring, approached NAG to discuss a mathematical model for an optimization problem and possible solutions.

The Problem

PSI had been asked by their customers to provide new solutions to improve the overall efficiency of pump stations along their pipelines. The main objective was to optimize the simultaneous operation of pumps while maintaining pressure level and flow rates.

The pipelines are currently under operation. All technical data including pump characteristics, pressure and flow as well as the number of pump stations and their location are available. Furthermore, operating costs, energy consumption, lifetime maintenance costs and other factors for each pump and each station are also available. Each pipeline is equipped with ten or more stations while each station has more than one pump. Pressure and flow can be controlled in different ways. Some customers do not run more than 3 or 4 pumps simultaneously due to unforeseen operational issues. This additional constraint limits the number of possible valid solutions.

Initial status

PSI asked NAG to improve the existing model and to reduce the computing time for large optimization problems.

Work done by the NAG Services team

The pipeline scenario has been modelled as a mixed integer programming problem with tens to hundreds of variables. The NAG Numerical Services team has extensive knowledge and expertise in this area of optimization.

Both NAG and PSI teams discussed the details of the current model to define possible alternative formulations for the specific problem. Some constraints were found to be redundant and further new formulations were proposed to improve the speed of the solver. At the same time a small set of potential numerical solvers were considered including open source offerings and NAG Library routines.

The range of potential solvers was reduced by considering only those that could be integrated easily within the PSI commercial application in terms of language and licencing. A fast and stable solver has been selected to meet all requirements.

In addition the NAG team suggested the use of special optimization modelling languages to develop alternative models more readily. An appropriate language was proposed for model validation and performance testing.

Finally, the new solver was tested successfully with the new optimization model.

Outcome

The new solution provides substantial improvements and benefits. The complete optimization problem has been solved within 0.5 seconds.

Quote:

'The help that NAG services provided was invaluable for us,' said Michael Krätsch of PSI. 'The increase in speed that we are now able to achieve, when solving our specific pipeline problem, was amazing and the knowledge we were given about optimization solvers, problem formulation and modelling techniques was more than we hoped for. The NAG people are a pleasure to work with and I couldn't have wished for more from any consultancy engagement.'